A BIO-MOLECULAR MACHINE AND ACTUATOR FROM THE MESOSCOPIC STANDPOINT

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In our macroscopic world, an mechanical efficiency of energy and works becomes bad as its size becomes smaller. Because, much of energy supplied for our macro-machine is wastefully abandoned witthout being converted into the effective works. This evidence means that every machine(i.e. bio-machine, macromachine) has the appropriate structural size or energy scale working efficiently. Moreover, we have analytically showed that the protein or bio- tissue, which had an appropriate stiffness or softness, was much suitable for biological structural materials in order to construct the biological actuators[1]. It is another serious problem that the thermal noise, fluctuation, prevents the operation of machine when we attempt to promote the machine' minute-ization of its. If we would like to improve these serious troubles, the molecular machine, which takes advantage of thermal noise, should have the elastic body and structure breaking the symmetric thermal surroundings, (i.e. thermal equilibrium), and we should establish the open stationary and dissipative state between the molecular machine and outer surroundings. The one powerful method is a utility of stochastic resonance(SR) and our model(SIRM, Stochastic Inclined Rods model), and we have already showed that the efficiency of SIRM have been improved as well as that of natural actin myosin system as shown in our papers[2]-[4]. The second way breaking the thermal balance is the method using the asymmetric tunnel effect of an electron and the fluctuation dispersion relation. If molecular machine has the asymmetric potential, the different tunnel current generates in its body and electric circuits. The value of current is expressed as

$$\Delta T = \frac{4E(E-V_1)}{4E(E-V_1) + V_0^2 \sin^2 kl} - \frac{4E(E-V_2)}{4E(E-V_2) + V_0^2 \sin^2 k'l}$$

, and in the case of more micro scales:

$$T = \exp\left(\frac{-4p}{h}\int_{R}^{b} dr \sqrt{2m\left(\frac{2Ze^{2}}{r} - E\right)}\right)$$

Thus, we realize that this current works as driving force which moves the molecular machine in one direction.

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